

Trends in Cancer Diagnoses among Inpatients Hospitalized with Stroke

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Background: Cancer, by conferring a hypercoagulable state, may lead to an ischemic stroke. Relatively little is known about the prevalence and evolution of cancer among stroke patients over the last decade. **Methods:** We used the Nationwide Inpatient Sample to identify discharges with any *International Classification of Diseases, Ninth Revision*, diagnosis code for cancer and ischemic stroke from 1997 to 2006. We then calculated age-adjusted yearly acute ischemic stroke hospitalization rates among adult populations with and without cancer. **Results:** Prevalence of cancer among hospitalized stroke patients increased from 1997 to 2006 (N = 31,075 [9.1% of all ischemic stroke hospitalizations] to 34,138 [10.6%], $P < .0001$). The most common types of cancer among hospitalized stroke patients in 1997 and 2006 were prostate (21% versus 19%), breast (19% versus 19%), gastrointestinal (16% versus 13%), and colorectal (13% versus 13%). Over the decade there was a significant decrease in the prevalence of stroke hospitalizations (slope -3.02 , 95% confidence interval -3.69 to -2.34), but not among cancer patients (slope 1.35 , 95% confidence interval -0.88 to 3.58). **Conclusion:** About 1 in 10 hospitalized ischemic stroke patients in the United States has comorbid cancer, and there has been a slight rise in this rate over the last decade. This is likely due to enhanced survival from better cancer treatments, but further study is warranted. **Key Words:** Cancer—stroke—trends—prevalence.

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Stroke and cancer are leading causes of mortality in the United States and their prevalence and incidence increase as the population ages.^{1,2} Advances in medical care have expanded life expectancies for individuals with either condition.³⁻⁵ As cancer patients live longer, they are exposed to a greater risk of stroke. In addition to the expected increase in stroke incidence that comes with being alive longer with a cancer diagnosis, there may be an added risk. Cancer is recognized as a non-traditional

risk factor for stroke and about 15% of cancer patients have ischemic events.⁶

There are 2 broad categories of stroke mechanism in cancer patients: traditional risk factor-related and tumor-mediated. In cancer patients with traditional stroke risk factors such as hypertension, diabetes, atrial fibrillation, and dyslipidemia, tumor-specific mechanisms are less likely to play a role.⁷ It is easier to attribute stroke to cancer when classic risk factors are absent. The

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Inpatient Sample is the largest all-payer inpatient care database in the United States, containing data on more than 7 million hospital stays from approximately 1000 hospitals, and was utilized for this analysis.

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relationship between the 2 categories of risk factors may be more complicated due to cancer-mediated mechanisms such as hypercoagulability, which may increase stroke risk to a greater extent in the presence of atherosclerosis.

There are very few large-scale epidemiologic studies on stroke in cancer-afflicted persons. Therefore using a nationally representative United States data set, we aimed to: (1) assess the proportion of hospitalized adult acute ischemic stroke patients with a comorbid diagnosis of cancer (overall and by type); and (2) characterize trends in stroke admission in those with and without cancer.

Methods

Data were obtained from the Nationwide Inpatient Sample (NIS), developed as a part of the Healthcare Cost and Utilization Project (HCUP). The NIS approximates a stratified 20% sample of all non-federal, short-term, general, and specialty hospitals serving adults in the United States. The sampling strategy selects hospitals within states that have State Inpatient Databases according to defined strata determined by ownership, bed size, teaching status, urban/rural location, and region. All discharges from sampled hospitals for the calendar year are then selected for inclusion into the NIS. To allow extrapolation for national estimates, both hospital and discharge weights are provided. Detailed information on the design of the NIS is available at www.hcup-us.ahrq.gov. From 1997 to 2006, the NIS captured discharge-level information on primary and secondary diagnoses and procedures, discharge vital status, and demographics for several million discharges annually.

The NIS is a part of the HCUP, a federal-state-industry partnership, and sponsored by the Agency for Healthcare Research and Quality. The NIS database brings together the data collection efforts of state data organizations, hospital associations, private data organizations, and the federal government to create a national information resource of patient-level health care data. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to health care programs, and outcomes of treatments at the national, state, and local levels.

All patients with a primary diagnosis of ischemic stroke were included whether they were alive or dead at the time of discharge. To analyze percentages of hospital-based stroke diagnoses, all discharges with *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 433.xx, 434.xx, or 436 included in any of the diagnoses were identified. For patients with more than 1 reported code, only the first reported code was included to avoid double counting patients with multiple reported

codes. Total number of stroke hospitalizations was obtained by summing across codes.

We calculated age-adjusted yearly acute ischemic stroke hospitalization rates in the US adult population with and without cancer across the 10-year study period. We collected data on type of cancer. Trend *P* values were computed by including year as a continuous variable in the logistic regression models while adjusting for the NIS survey design. We also plotted the primary stroke hospitalization rates in the general cancer-negative versus cancer-positive population in the United States, and computed the weighted frequency of primary stroke hospitalizations in cancer-positive versus cancer-negative patients to obtain the rate numerators. Rate denominators were derived using US census data for the total number of persons with and without cancer in the United States. Rate comparisons were performed using the *Z* test. All data analyses were conducted using SAS (Version 9.1, SAS Institute Inc, Cary, NC).

Results

Ischemic stroke hospitalizations among the US population with and without cancer were evaluated for the decade from 1997 to 2006 (Table 1). In 1997 there were 124 hospitalizations for ischemic stroke per 100,000 person-years for non-cancer patients and 257 hospitalizations for ischemic stroke per 100,000 person-years in those with cancer. Although the rate of ischemic stroke hospitalization decreased to 97 per 100,000 in the non-cancer group by 2006, it remained 274 per 100,000 in the cancer population. When looking at data over the decade (Fig 1) there was a significant decrease in ischemic stroke hospitalization in the cancer-negative group (slope -3.02 , 95% confidence interval -3.69 to -2.34 , $P < .0001$) and no significant change in the group with comorbid cancer (slope 1.35 , 95% confidence interval -0.88 to 3.58 , $P = .2691$).

The types of cancer diagnosis among hospitalized stroke patients are described in Table 2. The most common cancers seen in hospitalized stroke patients in 1997 were similar to those in 2006 and included prostate, breast, gastrointestinal, colorectal, and lung. Hospitalized stroke patients had a mean age of 77 years and half were women.

The number of ischemic stroke hospitalizations overall and with a cancer diagnosis was evaluated to determine the proportion of stroke admissions with cancer diagnoses (Table 3). There was a steady increase in the proportion of stroke hospitalizations over the decade from 9% in 1997 to over 10.5% in 2006.

Discussion

In the United States, while the number of stroke hospitalizations over the 10-year period of observation has declined, the prevalence of cancer among patients

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